LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published by
The Texas Company, 135 East 42nd Street, New York City
Copyright 1938 by The Texas Company
Vol. XXIV September, 1938 No. 9

Change of Address: In reporting change of address kindly give both old and new addresses.
"While the contents of LUBRICATION are copyrighted, other publications will be granted permission to reprint on request, provided article is quoted exactly and credit given to THE TEXAS COMPANY."

The Lubricating Engineer and Continuous Rolling of Strip Steel

MASS rolling of steel was one of the ideals of the engineering profession during the middle of the Nineteenth Century. Henry Cort had proved it could be done just after the American Revolution. He was confined to puddled iron, however, for until Bessemer developed his converter, steel, as we know it today, was but a name. Rolling became a reality therefore with the application of the Bessemer process and the open hearth for the conversion of iron to steel. Steel was a most necessary adjunct to the extension of the railroads and the perfection of our modern heavy duty machinery, as such it became one of the basic industries essential to present day civilization.

The Steel Industry has naturally had its fluctuations over the years which have attended its development. But it has ever gone forward in the perfection of more effective mechanisms for converting and rolling. From the early development of rounds and flats the production of an amazing variety of shapes has become practicable with almost uncanny accuracy. All this requires power to virtually an unlimited extent, and maintenance of rolling mill equipment in a state of almost flawless perfection.

The early "two-high" and "three-high" rolling mills which followed the perfection of the Bessemer and open hearth processes were continuous to the extent that the rolls rotated constantly in the same direction. In the "two-high" mill of Cort's day the steel was laboriously returned by hand to the front end of the mill; then came the "three-high" idea which solved the labor problem to some extent, but still the steel had to be lifted to the upper rolls until the tilting table was developed.

The reversing mill followed shortly thereafter to render the process of rolling even more mechanical.

All the above were Nineteenth Century developments. The modern four-high continuous strip mill is distinctly a Twentieth Century advancement.

MILL OPERATIONS

The earlier mills of this type required three stands of rolls similar to the "three-high" blooming mill, two of these rolls turned one way, the other rolling in the opposite direction. In such a mill the billet must be directed by guides through the proper passes to the first and third stands. It is then elevated automatically and directed to other guides which carry it back through the second set of rolls. The construction of these guides is unusual and their type of service is severe for, of course, they come in direct contact with the hot metal.

All this places a direct responsibility upon the lubricating engineer, not only in his original selection of lubricants, but in his study of mechanisms to apply them most positively.

In connection with this matter of lubrication he has had to deal primarily with bearings and gears, exposed to high pressures, high temperatures, and contamination of lubricants by water, scale and dirt. When he was dealing

with hand lubrication of such elements as was customary during the early developments of steel rolling processes, he had to provide for protection of rough crude mechanisms by lubricants which were sometimes almost as crude.

Today, however, he is assisted by improved types of bearing design, by systems for automatic handling of lubricants, by oil-tight gear housings, by precision roller bearings, and lubricants adapted to the above which the petroleum industry has spent millions of dollars in research to perfect. In consequence, there is more nearly a specific lubricant for every purpose in the steel mill today, than ever before.

One Direction Operation

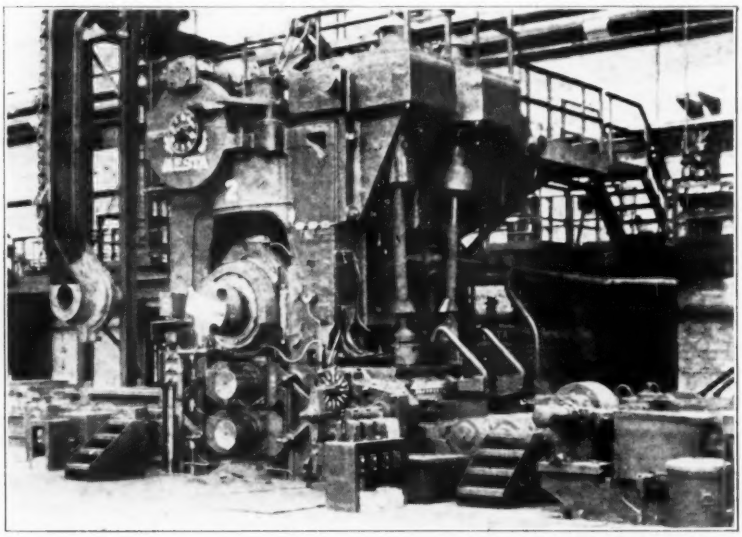
Modern finishing mills are of the continuous type in that they operate continuously in the same direction. They include all the necessary stages whereby rails, plates, strips and structural shapes are produced. When designed for high-speed service the slabs may go through from the bloomer under one heat. More frequently, however, the steel must be reheated before it passes to the roughing stand, so it is delivered to a charging machine which feeds these slabs to the reheating furnace. After being raised to a red heat they are discharged to the run-in table of the roughing mill. This gives the first reduction in size. It takes place just after the slab has passed through a set of preliminary edger rolls. During these two passes a considerable volume of water at high pressure is blown over the steel to wash off the scale.

The pinion and roll neck bearings, as well as the edger gears, are obviously subject to some of this water, especially if they are not carefully housed. In case of the latter, the respective lubricants will probably be contaminated, not only with water, but also with some scale. Builders of both rolling mills and lubricating systems have appreciated this, and observe every precaution to prevent such leakage by using the most modern types of seals.

A set of edger rolls is usually installed just preceding each roughing stand. In the strip mill the strip is then subjected to a series of continued reductions by successive rolling through a number of finishing stands until it reaches the coiler which automatically rolls or coils the strip. Rails, structural steel and plates, however, must be cut by saws to facilitate handling; bars, rounds and flats, in turn, being cut by flying shears. Here transfer tables are involved.

The Coiler

This unit comprises a rotating member surrounded by segments containing two guide rolls each. These rolls are carried on roller bearings provided for grease lubrication. Protection of these bearings is important due to the heat which is still retained by the strip, and the flood of water which deluges the coil during winding. The problem, however, is not so much to find a suitable grease, as to protect the distributing pipes from the pressure lubrication system, against the flapping end of the strip as each coil completes its winding and is discharged from the machine. A good quality lime soap grease containing about a 1100/1200 S.U.V. oil will perform satisfactorily if fed through brass delivery pipes which can be more or less moulded to the end surfaces of the roll segments and thereby kept away from the end of the coil; guards are not entirely dependable as they are too easily knocked off.



Courtesy of Trabon Engineering Corp.

Fig. 1—A vertical roughing and edging mill designed for grease lubrication by the Trabon automatic hydraulic pump. 33 points receive lubrication by this system.

ROLL NECK BEARING DEVELOPMENT

Paralleling the development of the continuous strip mill has been the development of two widely different types of bearings for roll neck service, viz.:

The Heavy Duty Roller Bearing, and
The Flood Lubricated Sleeve Bearing.

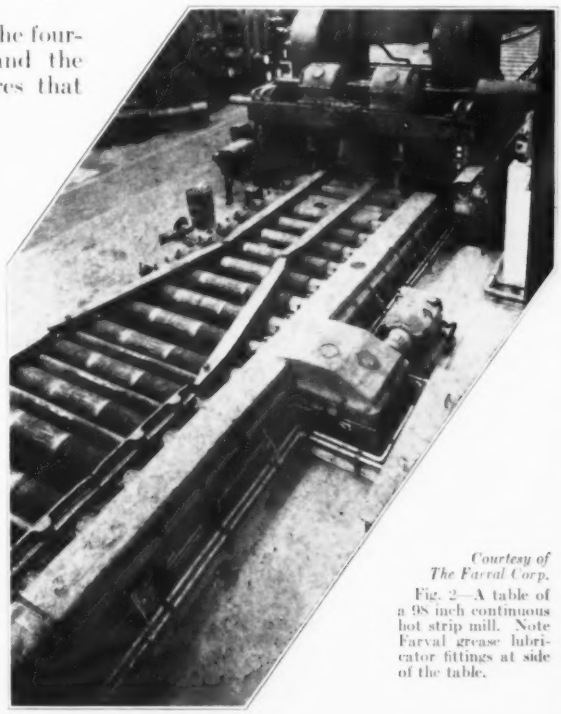
Both created a demand for lubricants of specific characteristics, of a degree of refinement hitherto not called for in mill service.

THE ANTI-FRICTION ROLL NECK BEARING

When this type of bearing was used on roll necks of two-high mills it was of necessity limited to light load service, for in order to provide space for the installation it was necessary to reduce the diameter of the roll necks to such a point that bending became a factor. This affected the life of the bearing and roll neck and resulted in high maintenance cost.

With the advent of the four-high mill, however, and the heavier rolling pressures that resulted, bearing designers gave more thought to load-carrying capacity. The larger diameter of the rolls and the greater difference in diameter between the necks and roll barrels offered an advantageous point of application for the roller bearing.

In the beginning it was attempted to apply such bearings to both the work rolls as well as the back-up rolls, and many contemporary lubricating engineers used oil for their lubrication. Today, however, the roller bearing is widely preferred for the work rolls with a centralized greasing system for lubrication. Then came the demand for a grease having extreme pressure characteristics which could be pumped through long lines even under low atmospheric temperatures. The modern E.P. grease has evolved, capable of withstanding severe loading without separation and able to seal the bearing against water, scale and mill dust.



Courtesy of The Farval Corp.

Fig. 2—A table of a 98 inch continuous hot strip mill. Note Farval grease lubricator fittings at side of the table.

Pressure Grease Circulation

One of the most prominent of the recent advancements in the lubrication of steel mill machinery has been the development of centralized greasing systems. The basic principles of all, regardless of their design or mode of operation, are the same, viz., the positive delivery of measured quantities of grease at periodic intervals, the exclusion of non-lubricating foreign matter; economy of lubricants, minimum hazard in handling or filling, and remote control. These principles relate particularly to the steel mill type of heavy duty roller bearing. The advantages of pressure were soon realized. So study of means for centralized lubrication of such bearings was a logical consequence.

There are a number of ways by which the lubricant can be controlled and impelled to the various points of delivery. In all, however, power in some form or other must be used. Where positive piston displacement types of metering valves are employed at each point to be lubricated, hydraulic power has been found to be especially adaptable as a means of valve control. In such a system as designed for table rolls, and the bearings of the coiler and other heavy duty machinery, either one or two lubricant supply lines can be connected to each valve according to the nature of the service.

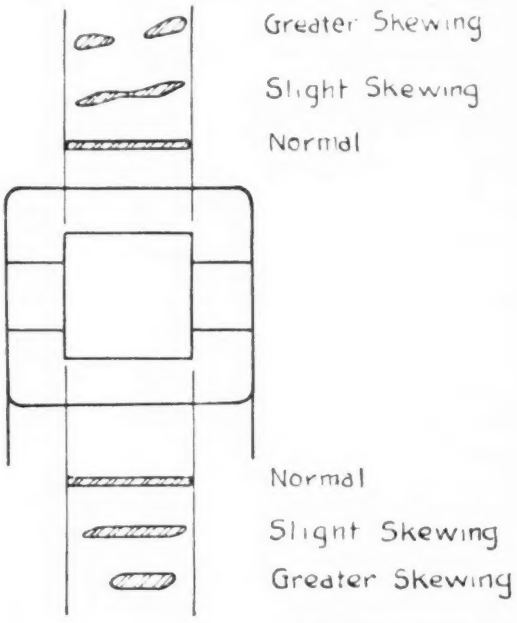
Where two lines are employed, pressure is applied alternately, each line receiving pressure over a prescribed period during which this line discharges each of the valves. The time between pressure applications will serve as the time interval between operations of the system.

In the single line system, the required grease pressure is developed by using an hydraulic fluid for transferring the power from the electric motor to the grease pump itself. By employing a large piston, subject to very slow motion, a considerable quantity of grease can be handled, air pockets are effectually eliminated, and the system gives long and satisfactory service.

There are other types of pressure greasing systems which require electric power or compressed air for their operation. Some of them are designed to eliminate the necessity for springs, check valves or restricted port openings.

Where intermittent pressure is exerted upon the lubricant between operations of the system,

the lines are under no pressure. This type of operation gives the grease the best conditions under which to operate, assures of positive flow and assists in the elimination of air pockets. The latter are always objectionable, although



Courtesy of Marlin-Rockwell Corp.

Fig. 3—Showing the effect of skewing in a roller bearing, according to Thomas Barish, Assistant Chief Engineer, Marlin-Rockwell Corp., in a paper discussing the theoretical comparison of ball and roller bearings, presented last April before the American Gear Manufacturers' Association. It was emphasized that for a roller to make use of its full contact area it must be kept exactly parallel with the shaft. If this contact area is disturbed, note how it would appear and the potential effects upon wear.

their development will depend to some extent upon the body of the grease: the heavier the latter, the greater the possibility of air pockets being formed.

Bearing Design

In studying grease lubrication, as applied to the modern continuous mill, it must be realized that, as we are dealing chiefly with the roller bearing, an understanding of the basic principles of bearing design are necessary.

For a roller bearing to function as intended each roller in the assembly must be set with its axis absolutely parallel to the axis of the rotating shaft. Under such a condition the contact area is rectangular. This must be maintained if the bearing is to continue to operate successfully. Any variation in parallelism, due to skewing of a roller will lead to alteration of the rectangular contact area, as indicated in Fig. 3. It becomes a function of the designing engineer to provide against skewing by planning his roller guides accordingly. This becomes more difficult as rollers are increased in length or possess a greater diametric difference with respect to their races.

Roller bearing guiding requires careful attention to lubrication wherever steel-to-steel rubbing surfaces are employed. Positive circulation or transmission of lubricant over these surfaces must be assured if the guides are to function as intended, in maintaining roller alignment.

Unit Lubrication

To further enable positive lubrication of the steel mill roller bearing, regardless of unexpected contingencies, unit lubrication has been developed to a high degree of efficiency by some mills. By this term is meant the treating of each mill stand or finishing machine as a unit, and building individual lubricating systems into each. In this way interference with the lubrication of any particular unit enables segregation of that unit. During the repair or overhaul period, in particular, grease lubricated parts can be protected by hand lubrication. This will enable the mill to continue rolling with no time loss or interference with production. Under such emergencies the portable pressure gun has been found to be an excellent stand-by device.

THE OIL-LUBRICATED MILL BEARING

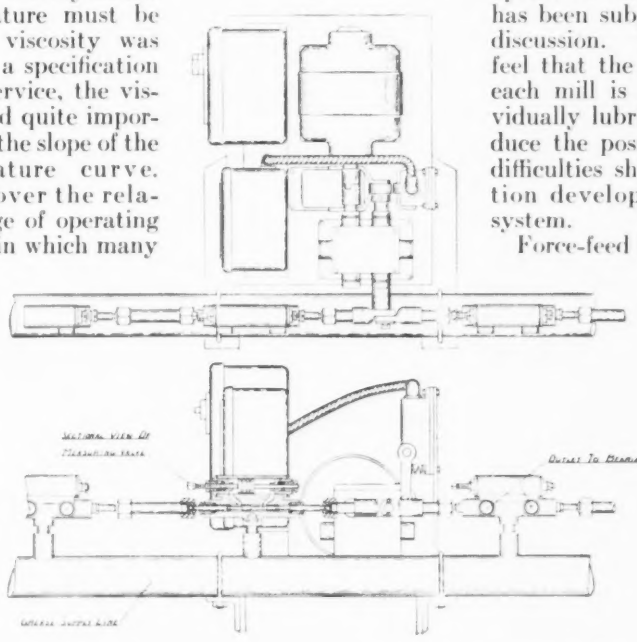
The perfection of the oil-lubricated, sleeve-type bearing led to the requirement of specialty lubricating oils of turbine grade to meet the fluctuating speed, load and water conditions. The advantages incident to continuous circulation of comparatively fluid oils were immediately obvious with this development and the design of lubricating systems capable of serving both gears and bearings with the same oil. Installations of this type are comparable to the steam turbine, involving operating conditions which require oils of similar characteristics, though usually of heavier body.

When the sleeve-type, flood lubricated bearing was first adapted to roll neck service the requirement for resistance to emulsification or high demulsibility was far more pertinent than it is today, for the construction of these bearings could not, at that time, positively assure against the entry of water. Later designs, however, by making use of specially designed seals, have materially reduced the possibility of water contamination. Tight fitting brass rings, leather cup seals or rubber are all used, according to the design of the bearing. It has been found good practice to install leather cup seals in pairs back-to-back, so to speak. The result of this attention to design has reduced the severity of service and become a definite

assistant to lubrication in enabling the oil to function free of possible emulsification and reduction in lubricating value.

One is therefore permitted to study more actively the relation of viscosity to speed. Furthermore, the viscosity at the operating temperature must be stressed. When viscosity was first considered as a specification for oils for such service, the viscosity index seemed quite important, as it denoted the slope of the viscosity-temperature curve. When observed over the relatively narrow range of operating temperatures within which many oils in a circulating system must function, the difference in operating viscosity is very slight.

It is today more important to consider the demulsibility, the viscosity with respect to speed, and the chemical stability.



Courtesy of R. M. Gordon & Company

Fig. 4—Arrangement of valves and valve tripper for the Gordon system of lubrication. This is electrically operated.

According to Morgan Construction Company, the viscosity should vary inversely as the speed. In other words, in a variable speed, continuous mill where the speed at the roughing end is low, a heavy oil is necessary, the bearings on the finishing end, being subjected to higher roll speeds, should in turn be served with a lower viscosity oil. To meet these conditions a range of from 250 to 2500 seconds Saybolt Universal Viscosity at 100 degrees Fahr. has been established.

In any consideration of viscosity, however, one must appreciate that under comparatively low speeds there may not be sufficient peripheral speed to completely throw out any entrained water. Obviously this becomes more apparent with heavier oils, as these latter (after usage) do not free themselves from water as readily as do light oils.

Development of the Circulating System

Circulation of fluid oils under uniform pressure conditions is conducive to these requirements, and helpful in reducing operating temperatures through the cooling effect of an excess of fresh cool oil. As a result, a variety of combinations were soon developed, ranging in simplicity from the unit type of gravity feed system to those multiple power devices whereby an entire series of roll stands can be served by oil under the same constant pressure.

The extent to which entirely automatic operation should be approached has been subject to considerable discussion. Certain authorities feel that the unit idea, whereby each mill is designed as an individually lubricated unit, will reduce the possibility of extended difficulties should faulty circulation develop anywhere in the system.

Force-feed lubrication became recognized as a most efficient method of bearing and gear lubrication with the perfection of the sleeve-type roll neck bearing and the oil tight gear housing. This led to the application of two basic types of systems for oil circulation, viz.:—

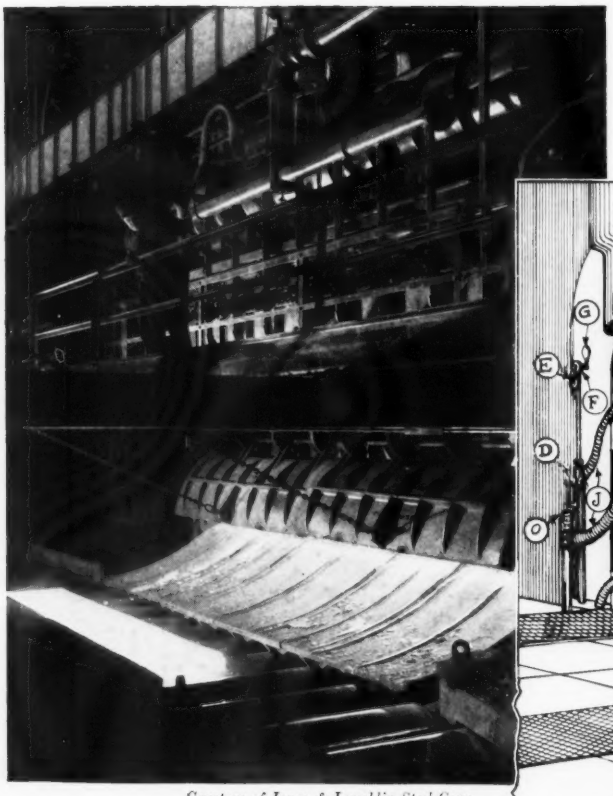
The Gravity System and The Full Pressure System:—

Both are designed to circulate cool, clean oil under uniform pressures, from a central reservoir, to bearings and gears to provide proper lubrication and to remove heat from the friction surfaces, thus avoiding abnormal operating temperatures.

Gravity Systems

In the operation of a gravity system the supply pump delivers oil from the settling or sump tank to an overhead supply tank which is mounted high enough to give ample pressure to the gears and bearings. An oil overflow line from the overhead tank to the sump tank returns all surplus oil delivered by the pump. From this overhead tank a supply line, through an assembly of lines delivers oil by gravity to the various points of lubrication; the oil then returns by gravity to the sump tank located below the operating floor.

Gravity circulation is the more simple of the two methods and no doubt does reduce the intricacy in construction and the necessity for costly automatic controls, but it is limited in regard to available pressure due to plant

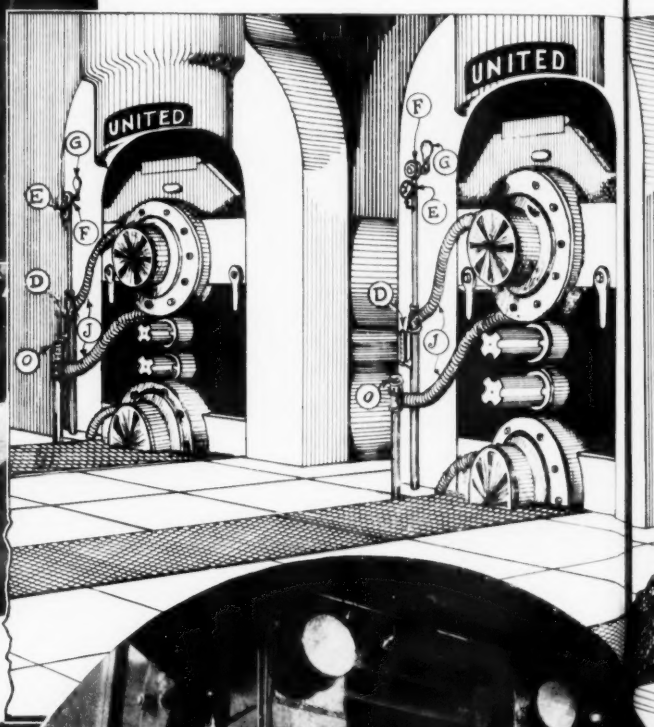


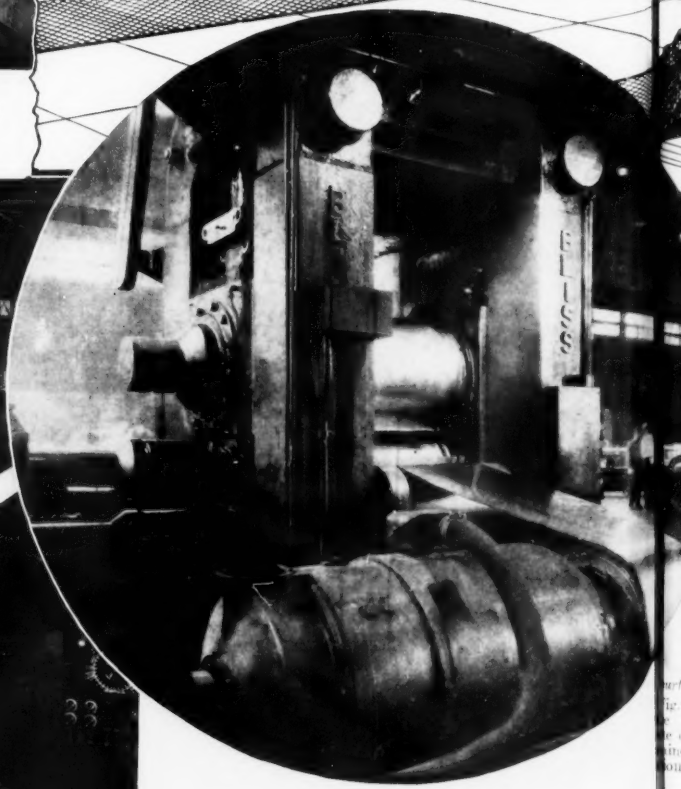
Courtesy of Jones & Laughlin Steel Corp.

Fig. 5—(Above) Showing a slab as it slides from the heating furnace to start on its way through a continuous strip mill.

Courtesy of S. F. Bo

Fig. 6—(Below) Typical oil piping arrangement for a Morgoil sle mill. Index: A–Globe (Throttle) Valve; B–Pressure Regulating Bypass; D–Thermometer; E–Pressure Gauge; F–Pressure Switch, tact; G–Signal Light; H–Low Pressure Howler; J–Flexible Steel K–Calibrating Plug; L–Main Supply Line; M–Main Drain Line Drain; O–Drain Vent.





Courtesy of Jones & Laughlin Steel Corp.

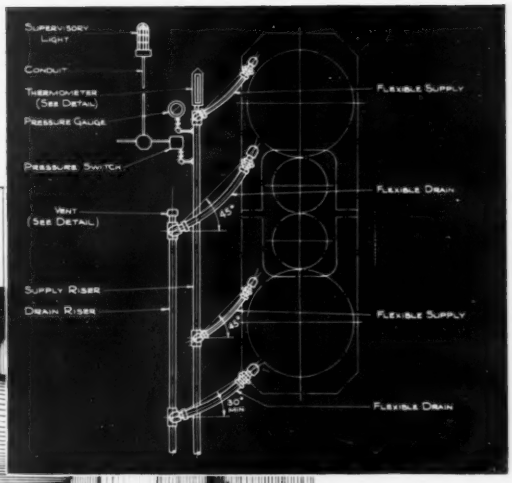
Fig. 8—(Left) Showing the red hot plate traveling at some 1400 feet per minute as it leaves the last finishing stand and is carried along the runout table to the cooling beds.

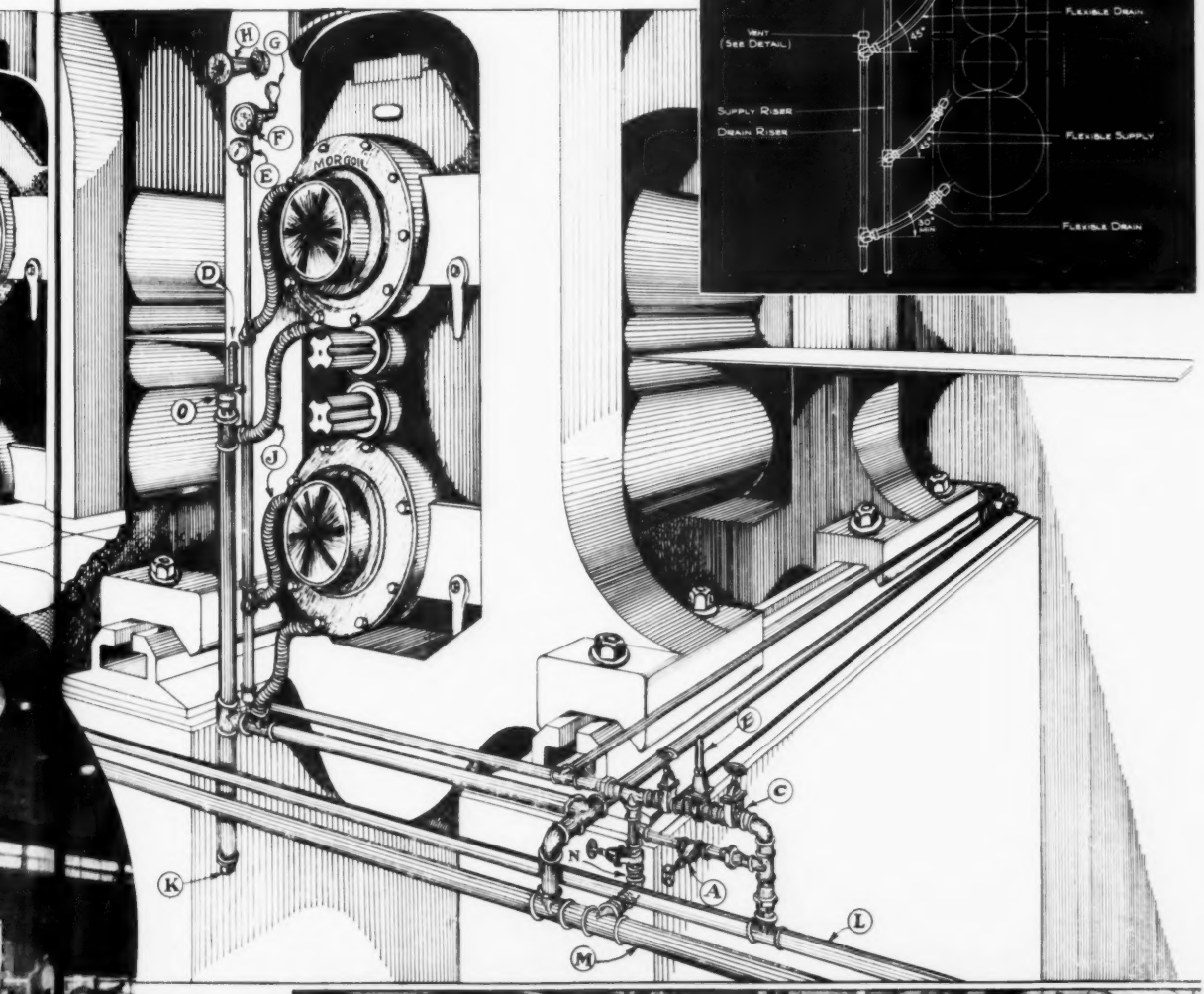
Fig. 10—(Right) The h a most important factor here the centralized fittings which serve the

F. Bos[illegible]mpany, Inc.
goil she[illegible]ng equipped
lating W[illegible]-Regulator
witch, [illegible]al Low Con-
[illegible] Steel [illegible]onnections;
in Line [illegible]oss Over to

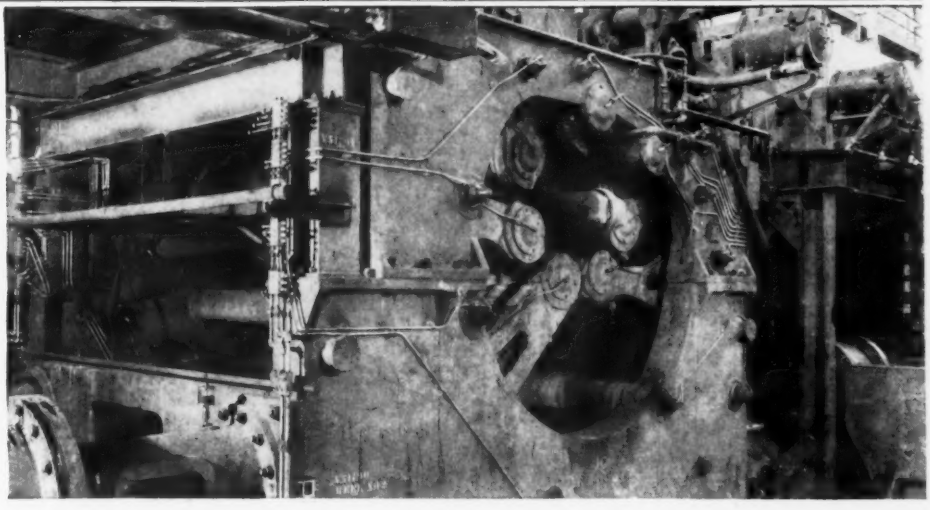
Courtesy of The De Laval Separator Company

Fig. 7—(Right) Typical piping arrangement at bearings for a pressure lubricating system on a continuous strip mill.





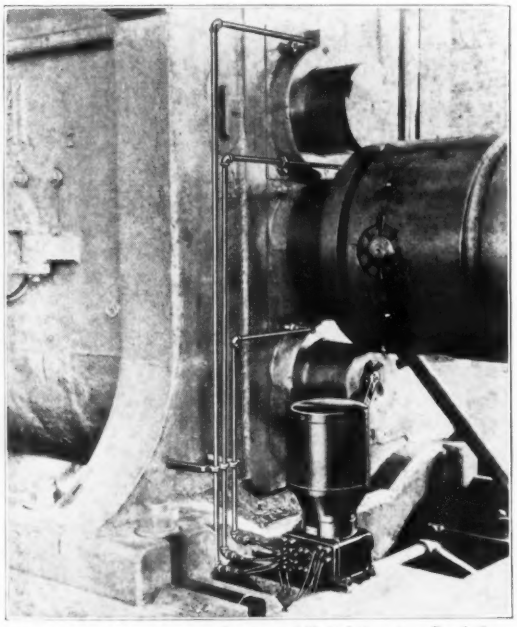
urtesy of E. W. Bliss Company
ig. 9—(Left) View of the Bliss
mill showing the general
e of cleanliness which can be
ined through automatic lubri-
ion.



Courtesy of The Farval Corp.
t) The ho[illegible]ip coiler and its lubrication is
t factor in [illegible] continuous strip mill. Note
ized press[illegible] grease lubrication piping and
rve the [illegible]s parts.

conditions. Where this pressure is low it may influence the choice of the viscosity of the oil which should be used.

Normally, with increase in pressure, the viscosity can be somewhat reduced. This reduction in body of the lubricating oil is compensated for by the added volume which becomes available through the increased pressure under which the oil is delivered.



Courtesy of United American Bosch Corp.

Fig. 11—Showing a rolling mill pinion stand, equipped for force feed grease lubrication. Note location of grease pump and essential piping.

The Full Pressure System

This method of lubrication is widely used for the lubrication of gear units and oil film bearings because of its pronounced flexibility. With the full pressure system the supply pump delivers oil at a predetermined pressure from the settling tank to a pressure tank in which an air cushion is provided at the top. Usually two pumps are provided, one of which serves as a spare. This latter cuts in automatically, by means of electrically operated pressure switches when the pressure in the pressure tank drops below a predetermined minimum due to failure of the operating pump, or whenever it is unable to maintain the desired pressure. If both pumps fail or are unable to maintain sufficient pressure a third pressure switch, which is set just below minimum operating pressure required, sounds an alarm in the operator's pulpit.

The expansive action of the air cushion in the pressure tank forces the oil through the main supply line and the numerous branch lines; these are equipped with orifice plates or valves to provide each bearing or gear unit with its proper share of lubricant. Frequently each of the various points of lubrication are equipped with a pressure switch and light signal to warn the operator should the oil flow be interrupted. The return oil from the gears or bearings flows back to the settling tank by gravity.

Reconditioning Features of the Oil Circulating System

The Oil Cooler

An oil cooler of ample size is provided to lower the temperature of the oil leaving the pressure tank. For best results an ample supply of cooling water must be provided for the cooler and the latter must be kept clean. Thermometers inserted in the oil lines entering and leaving the cooler serve as indicators as to the efficiency of the cooler.

Oil Filters

Pressure filters installed between the pumps and the pressure tank remove any foreign matter that might remain in the oil drawn from the settling tank. Filters of the latest design have a self-cleaning feature which requires very infrequent dismantling for the removal of the collected foreign matter from the filtering medium.

Centrifugal Purifiers

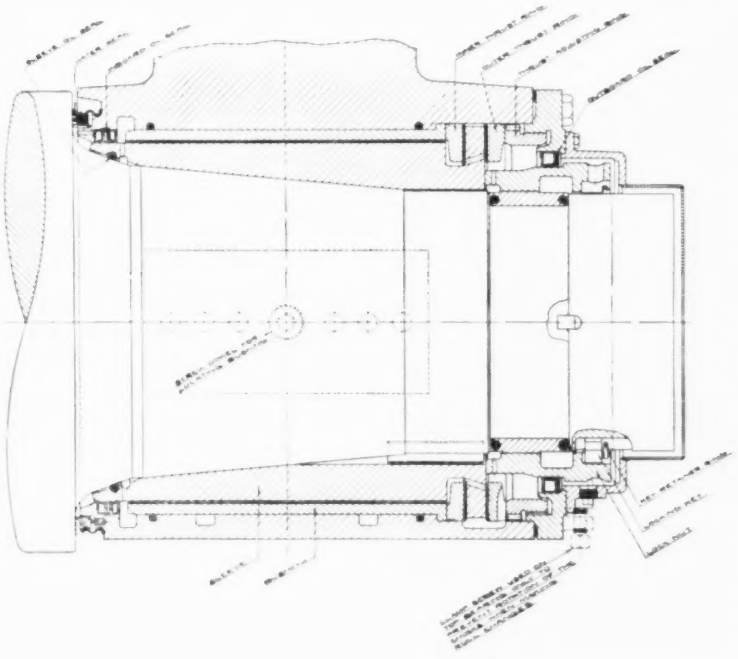
Many circulating systems will include one or more centrifuges which are usually operated intermittently for an hour or so each day. Where large quantities of water may get into the system, however, the centrifuges are sometimes run continuously until the source of the water can be found and the leak corrected.

Settling Tanks

With the possible exception of the circulating pumps, the settling tanks are the most useful and necessary features of the circulating system. Where there is any chance of considerable water getting into the system it is advisable to install two settling tanks, so that when the oil in one tank shows signs of emulsification the contents can be taken out of service for reconditioning. This is done by heating the oil by means of steam coils located in the bottom of the tank to a temperature sufficient to reduce the viscosity and enable the entrained water to settle to the bottom from whence it can be drawn off through drain valves.

A well designed settling tank will have several large clean-out valves located along the front and as near the bottom as possible.

It is also desirable to slope the bottom of the tank toward the front; then by periodically opening the drain valves, the accumulation of water and sludge in the tank can be held to a minimum. Floating suctions are also often installed to allow the pumps to take the cleanest oil which is found near the surface of the oil in the tank.



Courtesy of Morgan Construction Company

Fig. 12—Cross section of the Morgoil tapered neck sleeve type bearing, designed for fluid oil lubrication. Seal design has been most carefully studied to protect lubrication and prevent entry of water.

Any settling tank should be of ample size to allow the oil to flow through at minimum velocity, thus the oil entering at one end has an opportunity to drop out a considerable amount of its entrained moisture before it again reaches the pump suction at the other end. The tank should be kept as nearly full of oil as possible, due consideration being given to the expansion of the latter when heated for reconditioning purposes, because a full tank reduces the exposed surface on the inside of the tank and prevents excessive sweating; also it aids in the cooling of the oil and allows more time for the oil to drop out its moisture.

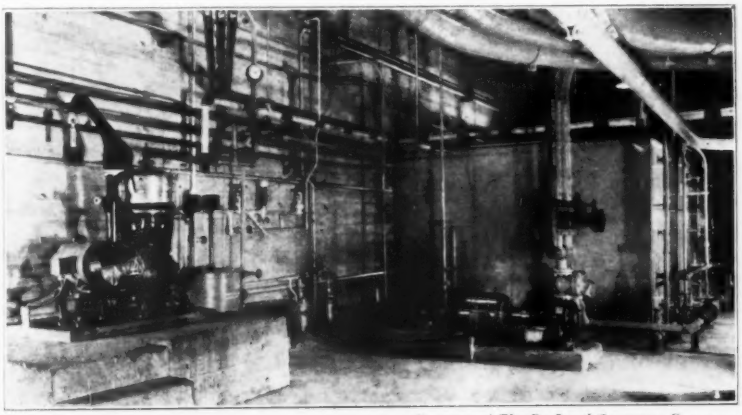
It is good practice to alternate the service of such tanks, thus allowing a batch of oil to be in service one week and then to rest for a week. This is a safety factor against formation of emulsions.

Relation of Oil Fluidity To Pressure

Relative fluidity, as measured by the viscosity and pour test, must always be carefully considered, especially at low temperatures; it becomes highly important in conjunction with the pressure available.

The pour test used to require particular consideration, for in cold weather or under low temperature starting conditions in exposed mills, the rate at which the oil could be returned to the settling tanks was affected. Should it become too sluggish at any time, flow off from a pinion housing or bearing might be impaired to develop backing up of the oil in the system. Furthermore, if any bearings were improperly sealed, oil might leak from the case. This would result in waste, also a sloppy condition on the operating floor.

In the modern continuous mill designed for pressure oil circulation, the elimination of oil baths and the use of heating elements has materially decreased the importance of the pour test. On the other hand, where the viscosity or pour test are too high the re-



Courtesy of The De Laval Separator Company

Fig. 13—A modern continuous mill oil cellar showing piping, pumps, tanks and purifier. Cleanliness is a feature in any system of this nature.

duced fluidity may develop marked increase in power consumption. This would prevail throughout the system, for not only would the circulating or oil delivery pumps be called upon to do extra work, but also the mill drives might feel the extra duty demanded due to the increase in internal friction within the lubricant itself.

Increase in the automatic nature of any such system requires even more careful consideration of relative fluidity. With extensive piping layouts and the possibility of abnormal friction losses occurring within the system itself, reduction in oil flow may result to a sufficient degree to require severe overloading of the pumps in order to keep the oil in the supply tanks at the proper level, and deliver the required amount to the bearings.

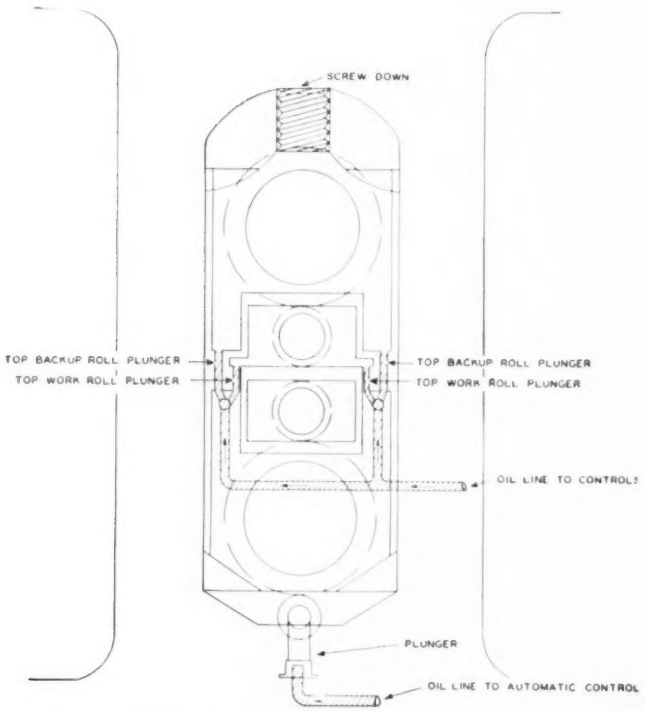


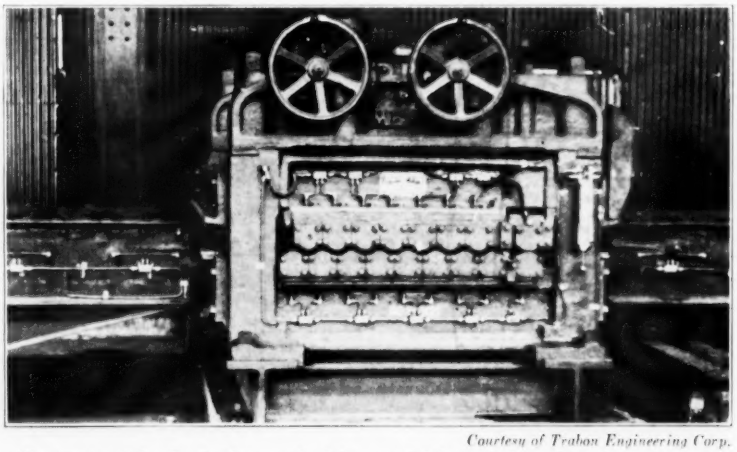
Fig. 14—A method of applying oil pressure to mill rolls to assist lubrication. Pressure via plungers to the top work and back-up rolls is constant during operation. Pressure on the fifth roll varies, automatically being maximum on starting and stopping.

Sleeve-Bearing Oil Requirements

Lubricating oils for the circulating oiling systems employed on certain types of enclosed gearing and the modern sleeve-type flood lubricated roll neck bearing, must be most carefully protected to assure of continued lubricating ability. Sludge is the nemesis of the steel mill lubricating engineer who is charged with the maintenance of these bearings. So he watches the demulsibility of his circulating oils quite as carefully as he does for his turbine oil. Fortunately, he has two assistants in this connection: The petroleum refiner who manufactures all these oils to a 1620 demulsibility, and the bearing and mill manufacturers who include the most effective methods of sealing against entry of water and solid foreign matter.

Regardless of these precautions, however, water will gain entry. The only recourse, therefore, is to remove it before it can lead to the formation of emulsions and certain types of sludge. In a relatively water-free system sludge can be present in the absence of an emulsion especially in an oil readily susceptible to oxidation. Furthermore, sludges can be either water-soluble or oil-soluble.

Emulsions are largely prevented by continuous removal of water; along with sludges they can be eliminated by centrifugal purification. Filtration in turn will remove solid contaminants and oxidizable material. The use of the centrifuge plus auto-



Courtesy of Trabon Engineering Corp.

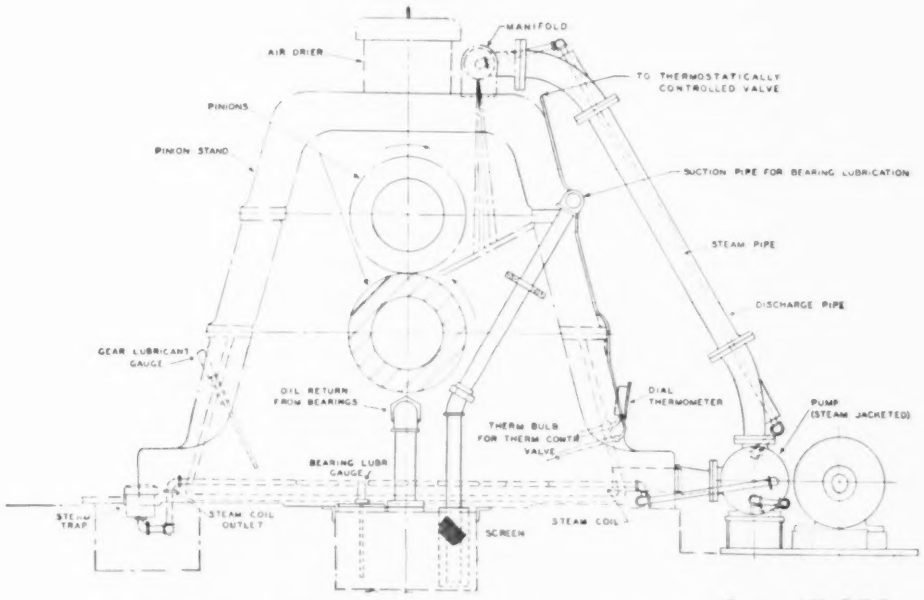
Fig. 15—A strip leveller showing certain of the grease lubricator fittings. Here the Trabon system serves 70 points.

matic and continuously cleaned filtration is quite as wide-spread as the bag or screen type filter. In any filtering element the uniformity of the filtering media must be maintained; in other words, variation in pressure drop across the filter media due to plugging is not desirable.

original design, in order to provide for some recognized method of sealing, which will not impair the free rotation of the shafts.

Methods of Sealing

Modern sealing methods have been carefully



Courtesy of The Falk Corp.

Fig. 16—Lubrication piping for a Falk 20 x 36 pinion stand. This is a thermostatically controlled pre-heating system whereby the lubricants under circulation can be maintained within very accurate temperature ranges. This is of definite advantage in steel mill service where atmospheric temperatures may vary very widely. Pre-heating is of definite advantage on cold starting. Conversely the above system can be used to permit cooling in extremely hot weather.

The amount of water which must be used on certain types of steel mill operations is considerable; furthermore it is usually contaminated. In brief, water is one of the primary agents in heavy duty rolling mill service in eliminating scale accumulation. Much of this water will deluge the bearings and drives. After passing over the hot metal it is dirty and of sufficiently high temperature to work its way into the lubricating system almost regardless of the care in design. Furthermore, at a temperature of very nearly the boiling point, water will have a decided tendency to react physically with any oil with which it comes in contact, to cause formation of permanent emulsions which may be very difficult to break.

Fortunately, water traps and settling tanks have been found to aid materially in removing a considerable amount of such water before it has time to affect the oil. All points wherein water may gain entry into such a lubricating system should be carefully sealed as added insurance. This can be accomplished in many cases by caulking surface joints with oakum, and covering with molten lead. With bearings, however, attention should be directed to their

studied by the builders to determine their adaptability to the oil lubricated sleeve type bearing. The perfected design of this bearing will rarely permit the entry of an excess of actual solid foreign matter; water leakage, however, may occur, or there may be some accumulation due to condensation. Seal investigation has therefore been directed towards reducing this water content. As already stated, brass rings, the rawhide or leather cup, and the compression type of rubber seal, have all proved their adaptability and are standard equipment today for the protection of such bearings.

The result has been very gratifying. Whereas but a few years ago it was expected that up to twenty per cent of water might gain entry and that at least part of the oil would most surely become emulsified; today, from two to four per cent is regarded as a high maximum, and the most modern installations report an even lower water content in their service oil.

It is obvious that these improvements in the mechanical structure of this bearing are of inestimable benefit to the oil industry, in that the load imposed upon their lubricating oils is materially reduced.

As a result, the normal water content in a modern finishing mill oiling system will be low —usually well under one per cent. In the lubrication of edger gear sets and the roll necks on the roughing mill, a much greater water content may prevail, due to the huge volume of water which is continually being discharged over the slabs. The centrifuge or settling tank must remove the majority of this water if the mill is to function effectively. Any failure may lead to rapid accumulation of sludge and possible loss of a roll neck bearing. When we consider that the latter may cost upward of $1,000.00, obviously the management is sympathetic to the lubricating engineer's plea for every possible means of protection.

Hence the provision for standby oil storage tanks; the use of several thousand gallons of oil circulated at a rate of 300-350 gallons per minute; and a multitude of indicating devices coupled with the reclamation system to keep the roller and lubricating engineer constantly advised of the performance of this system.

PINION AND GEAR LUBRICATION

Mechanized lubrication of steel mill pinions and gears has likewise progressed to a marked degree. The trend towards the enclosed and oil-tight housing; improvements in gear tooth cutting and fitting, and the perfection of circulating oiling systems, is noteworthy. In fact, the cumbersome exposed gear is a novelty in a modern continuous mill; all the necessary speed reduction mechanisms are as carefully housed as are the bearings, and usually the oiling system for each is so similar that one must be thoroughly experienced to tell them apart. All this has developed from the necessity for higher mill speeds with reduced gear tooth wear, less noise and greater cleanliness.

But not only are the roll stand gear and bearing lubricating systems alike; frequently they are designed to function on the same grade or type of oil. It is better, however, to serve each individually due to the usual differences in operating conditions and the variations in rate of oil circulation which may be necessary.

Oils for this work, however, cannot be regarded as all-service, enclosed gear lubricants. The design of the gear set becomes an influencing factor. In other words, some gears and pinions may be designed for extreme pressure conditions; they require specially prepared oils of high film strength, containing components capable of temporary chemical reaction (under high temperature and load conditions) with the surfaces of the gear teeth. By this reaction an auxiliary protective film is formed momentarily to prevent actual clean steel contact and subsequent tooth scuffing.

In service of this nature the oil must be constantly protected against abnormal contact with water, otherwise corrosive salts may be developed, and the protective ability of the oil impaired.

THE SCREW DOWN

This device which functions as the control element for the roller in regulating the amount of reduction developed by any roll stand, is another mechanism wherein the intensity of the load conditions may require the use of an extreme pressure lubricant. As its name implies it consists of two long screws driven by hydraulic or electric power, or through suitable gear mechanisms; its purpose is to raise or lower the rolls as necessary.

In the lubrication of the screw-down, one must counteract the effects of heat and pressure. The latter is reactive, and developed to a maximum at every pass of steel through the rolls. Radiated heat from the hot steel is meanwhile tending to reduce the body of any lubricant which is applied to the screws to render it sufficiently fluid to flow quite readily. The use of E.P. additives are therefore frequently resorted to, in order that the lubricating film may be as tough and resistant to rupture as possible.

HYDRAULIC POWER

The principles of hydraulics are made use of in the modern mill to facilitate initial lubrication when the rolls are started, and to reduce the direct load when stopping. This is accomplished by an oil hydraulic pump which develops the necessary static oil pressure to lift the roll sets just sufficiently to reduce the pressure of the necks on the bearings. All the while the lubricating oil circulating system is operating. The possibility of bearing wear under such an arrangement is materially decreased.

Hydraulic power is also used in the shear control to maintain accuracy of cutting. Here the more typical oil hydraulic power transmission is used. In contrast with the accumulator which is restricted to transmission of power in a straight line direction through reciprocating motion, the rotary type pump, with its accompanying rotary hydraulic motor, converts electric power as delivered by a constant speed electric motor operating in one direction, into hydraulic power of variable speed, capable of most accurate control.

Printed in U. S. A. by
EDGAR C. RUWE CO., INC.
72 Washington St., N. Y. C.